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Variability in Oil and Vernolic Acid Contents in the New *Vernonia galamensis* Collection from East Africa

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Epoxy oils are important in industry for the manufacture of plastic formulations, protective coatings, lubricants, and other products. Current industrial techniques are expensive, generate large amounts of chemical waste, and produce high viscosity oil. A natural low-viscosity, epoxy oil is now available from the seeds of *Vernonia galamensis* (Cass.) Less, a herbaceous member of the sunflower family (Asteraceae). The low viscosity and polymerizing characteristics of this oil make it especially valuable as a solvent in industrial coatings and paints, for environments where fumes from traditional solvents are hazardous or polluting (Kaplan 1989). Some of the products that are being developed from *Vernonia* oil are degradable lubricants and lubricant additives, epoxy resins, adhesives, insecticides and insect repellants, crop-oil concentrates, and the formulation of carriers for slow-release pesticides.

The development of alternative crops is receiving increased recognition as an answer to some of the problems facing today's agriculture. New industrial crops could significantly diversify American agriculture and create markets that are essentially noncompetitive with existing crops. They would also provide a reliable domestic source of essential industrial feedstocks such as unique oils, many of which are currently imported (Aziz et al. 1984; Cunningham 1987; Kaplan 1989; Perdue 1989; Perdue et al. 1986; Thompson et al. 1994a,b,c). Establishment of a new industrial crop such as *Vernonia* can be an answer to problems facing farmers today who need a "high cash" crop as a primary source of income. This is crucial in states where farms consist of relatively small acreages and who are dependent upon a single cash crop

Vernonia galamensis is an annual herb and native of Africa (Perdue et al. 1989). It grows in areas with as little as 20 cm of seasonal rainfall. Plantings in Virginia, Arizona, and other states showed that *Vernonia* is extremely resistant to insects and diseases. *Vernonia* seeds contain up to 40% epoxy oil and this oil has up to 80% vernolic acid (cis-12,13-epoxyoleic acid). Plantings in Eritrea, Kenya, and Zimbabwe confirmed that *V. galamensis* has an excellent seed retention compared to *V. althemantica*.

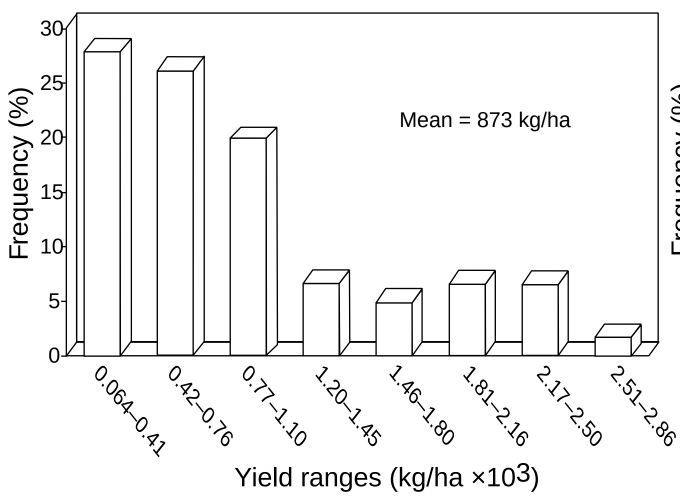

Fig. 1. Frequency of seed yield (kg/ha × 10^3) distribution in *Vernonia galamensis* accessions collected in Eritrea.

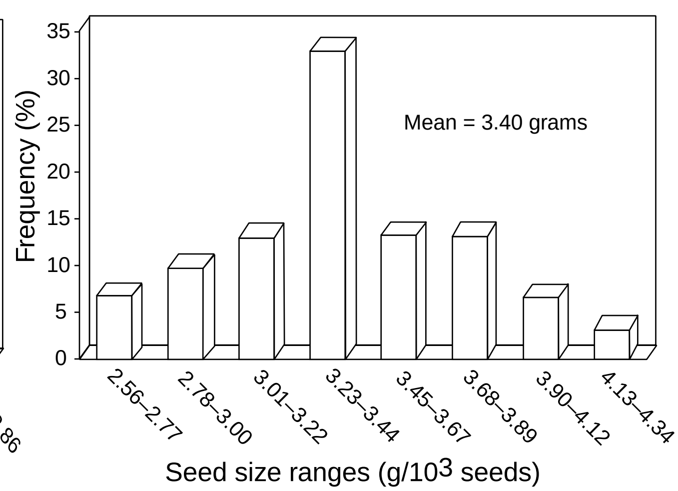

Fig. 2. Frequency of seed size (grams/10^3 seeds) distribution in *Vernonia galamensis* accessions collected in Eritrea.

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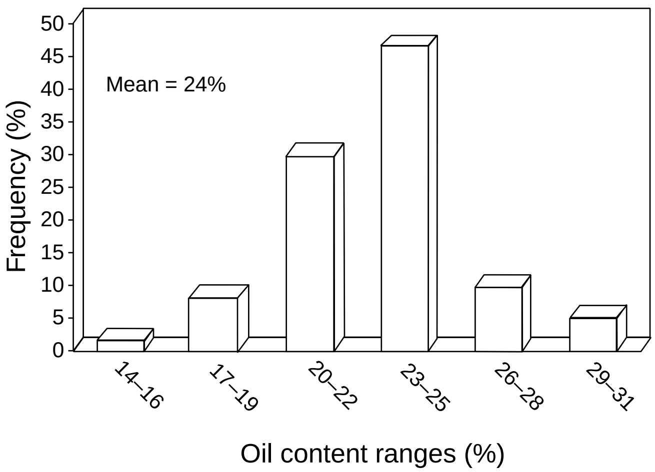

Fig. 3. Frequency of oil content (%) distribution in *Vernonia galamensis* accessions collected in Eritrea.

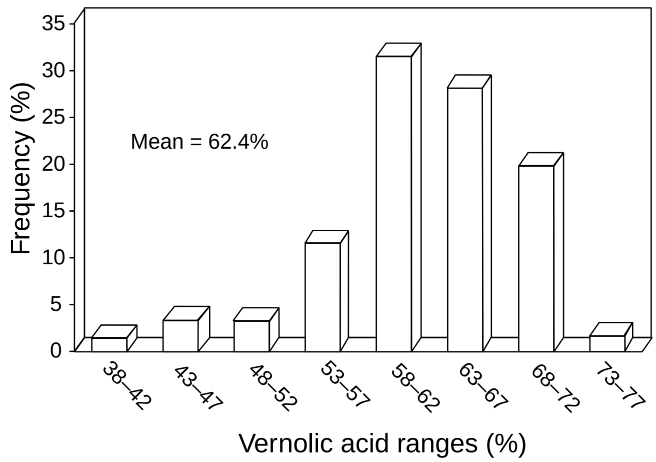

Fig. 4. Frequency of vernolic acid (%) distribution in *Vernonia galamensis* accessions collected in Eritrea

Despite the highly successful progress in domestication of *Vernonia* (Thompson et al. 1994a,b,c), substantial research is needed to evaluate *Vernonia* accessions, to make new selections for vernolic acid quantity and quality, and to determine the effect of environment, cultural practices, and processing on *Vernonia* oil. The main objectives of this research were to determine seed yield and yield components of the newly collected accessions and to determine oil content and fatty acid pattern

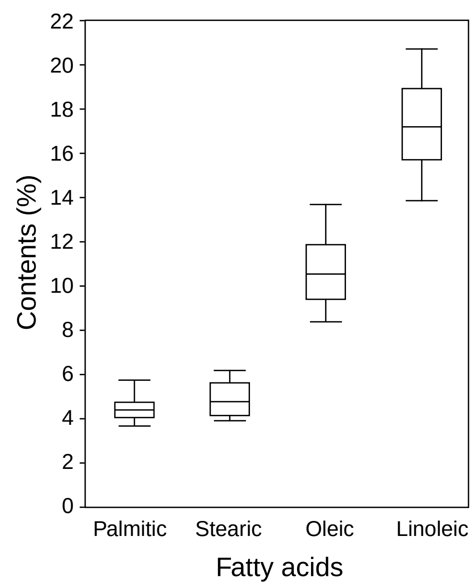

Fig. 5. Variations in palmitic, stearic, oleic and linoleic in *Vernonia galamensis* accessions collected in Eritrea.

GERMPLASM COLLECTION

The existing *V. galamensis* germplasm collection at ARS/USDA is limited to 63 accessions. During the first year of the project new accessions were collected from Eritrea and Ethiopia through a USAID/HBCU grant. Collection was done by selecting individual matured inflorescences and planted for seed multiplication in Eritrea. A total of 61 accessions was collected and planted each in a single row for seed multiplication at Halhale research station in Eritrea. Accessions with adequate amount of seeds including breeding lines received from the Water Conservation Lab at ARS/USDA, Phoenix, AZ were planted in a four-row plot at the same location. At maturity each accession was evaluated for seed yield, agronomic traits, seed oil content, and fatty acid pattern. Oil and vernolic acid were analyzed using the methods of Ayorinde et al. (1990) and Mohamed et al. (1995a,b).

EVALUATION

During the rainy season of 1996 in Eritrea, the 61 accessions evaluated for agronomic and chemical parameters demonstrated the existence of wide genetic variability that could give the possibilities for genetic improvement of the crop. Significant differences for seed yield, oil content and vernolic acid were observed among the 61 accessions evaluated. The mean seed yield was 873 kg/ha and ranged from 60 to 2800 kg/ha (Fig. 1). The variation in yield was also reflected in seed size and the mean size was 3.4 grams/10^3 seeds (Fig. 2). The mean of the total oil was 24% and ranged from 14% to 31% (Fig. 3) where the majority (46%) of the accessions fall within the overall mean. The vernolic acid mean of the accessions was 62% and ranged from 38% to 77% (Fig. 4) and 49% of the accessions had vernolic acid content which exceeded the mean. The fatty acid profile of the accessions is given in Fig. 5. Emphasis will be given to the accessions that gave highest seed yield, vernolic acid and oil.

A positive correlation (r = 0.28**) between oil percentage and vernolic acid was found. This indicates that breeding *Vernonia* for higher oil content will increase vernolic acid percentage. A highly significant and negative correlation (r = –0.90, –0.82, –0.95, and –0.96) were found between vernolic acid and palmitic, stearic, oleic, and linoleic acid, respectively.

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